

# Plasmoids formation in a laboratory and large-volume flux closure during simulations of Coaxial Helicity Injection in NSTX-U, Fatima Ebrahimi, PPPL/Princeton University

## Objectives

- **Transient CHI is used as a solenoid-free plasma start-up method in NSTX and NSTX-U.**
- Comprehensive 3-D resistive MHD NIMROD simulations have been conducted for the NSTX and NSTX-U geometries.
- To study the physics of fast flux closure and magnetic reconnection in order to achieve the maximum flux closure and plasma start-up current.

## Accomplishments

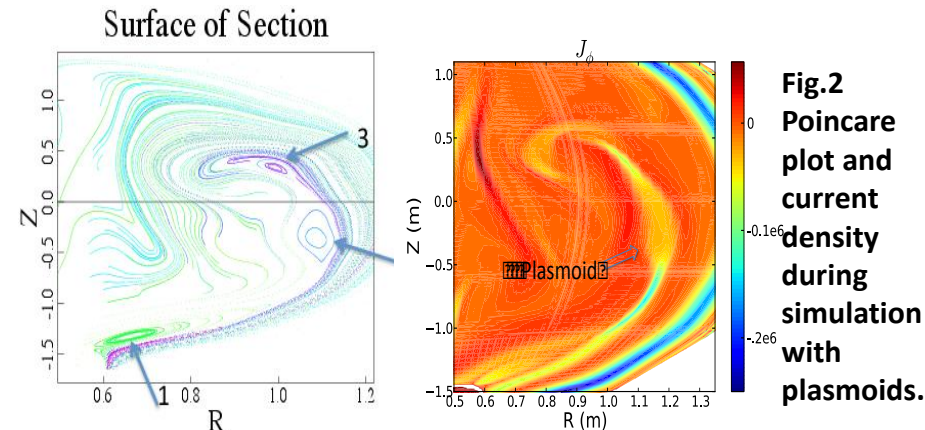
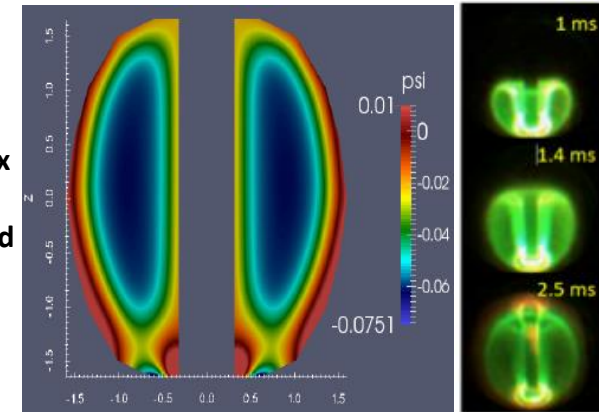
- **Two mechanisms for flux closure :**
- **Sweet-Parker (S-P) type reconnection** (electromagnetic forces cause oppositely directed field lines to come closer in injector region and reconnect)
- **New plasmoid mediated reconnection also observed** (the S-P current channel becomes unstable at high Lundquist number and breaks up into plasmoids that merge), see Fig. 2.
- A transition to plasmoid instability has for the first time been predicted by simulations in a large-scale toroidal fusion plasma [Ebrahimi & Raman PRL 2015]
- Motivated by the simulations, experimental camera images have been revisited and suggest the existence of reconnecting plasmoids in NSTX

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## Impact

**3-D simulations have now, for the first time, been able to show large fraction conversion of injected open flux to closed flux in the NSTX-U geometry, Ebrahimi & Raman NF 2016, and Ebrahimi et al. to be submitted.**

**Fig.1 Left: Poloidal flux in NIMROD simulations. Large volume poloidal flux closure, about 70% of the initial injected flux is closed; Right: fast camera images during NSTX experiments.**



**Fig.2 Poincare plot and current density during simulation with plasmoids.**



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